1.0 INTRODUCTION

The Coeur d'Alene Basin (CDAB) in northern Idaho has long been known to be contaminated by historical mining and smelting activity. Public health investigations in the 1970s to 1980s resulted in the designation of the 21 square mile area called the Bunker Hill Superfund Site (BHSS), or "the Box," surrounding the former ore refining complex near Kellogg. Recently, the United States Environmental Protection Agency (USEPA) has extended a Remedial Investigation and Feasibility Study (RI/FS) to include the larger area of contaminant release in the CDAB. This expansion resulted from the review of previous studies indicating areas outside of the original BHSS boundaries present a potential threat to human health and the environment. The RI is currently being undertaken to characterize the degree and extent of the contaminant release and the FS was initiated to select the most appropriate remedial action based on site-specific applicability, effectiveness, ability to implement , and relative cost. Concurrent with the RI/FS, the Human Health Risk Assessment (HHRA) is being conducted to determine potential health risks associated with residual heavy metals contamination in the CDAB. This document provides the HHRA for the areas east of Harrison upstream from the mouth of the Coeur d'Alene River.

1.1 SITE LOCATION AND BACKGROUND

1.1.1 Community and Industrial Development

The CDAB is a vast hydrologic drainage network of over 3700 square miles located in Shoshone and Kootenai Counties in Northern Idaho (Figure 1-1). The Coeur d'Alene (CDA) River flows west through the Basin for approximately 53 miles from the Idaho/Montana state border to Lake Coeur d'Alene which then drains to the Spokane River. It is estimated that as many as 10,000 people live in over 20 incorporated and unincorporated communities in the CDA Basin area (excluding the Bunker Hill Superfund Site and the city of Coeur d'Alene). Most of the communities included in the present study have developed at or near old mine portals and ore milling sites, or are adjacent to large mine waste (tailings) or contaminated alluvial deposits. Communities west of, and including, the city of Coeur d'Alene are not included in the present study as explained in Section 2.1, and more specifically in 2.1.5.

The Coeur d'Alene Basin including Lake Coeur d'Alene and the St. Joe, Spokane, and Coeur d'Alene River Basins was the ancestral home of the Coeur d'Alene Indian nation for centuries prior to the coming of European immigrants in the mid to late 1800s. Agricultural settlements developed around the Jesuit missions in the area during the mid 19th century. The existence of significant deposits of gold, silver, and lead was first reported in the Coeur d'Alene Mining District in 1882 (Day 1963). Subsequently, several mining towns developed in the upper Basin and these areas were extensively mined and became one of the largest and most productive lead, silver, and zinc producing areas in the United States, namely northern Idaho's Silver Valley. The Bunker Hill and Sunshine mines, near Kellogg, Idaho, were among the largest silver and lead producers in the United States, and several

mining companies are still active in the area today. Over 100 years of past mine waste and over 60 years of smelter emissions have been discharged into the CDAB.

The Upper Basin, for the purposes of the HHRA, is contained in a steep mountain canyon of the South Fork of the Coeur d'Alene River and adjacent tributary gulches. The Upper Basin contains 11 residential cities or unincorporated areas, about half of which are located within the BHSS. This area is the heart of the world famous Coeur d'Alene mining district that was a major producer of silver, lead, zinc and other metals throughout the last century.

The 21-square mile Bunker Hill Superfund Site (BHSS) (National Priority Listing - September 8, 1983) is located on the South Fork of the CDA River near the center of the upper Basin. The communities of Kellogg, Smelterville, Wardner, Page, and Pinehurst are located within the site boundaries (Figure 1-1). Two Records of Decision (RODs) have been completed for the BHSS (one for the populated areas in August 1991 and a second for the non-populated areas in September 1992) (USEPA 1991c, 1992b). When the site was in full operation, it included: a milling and concentrating operation, a lead smelter, a silver refinery, a cadmium plant, an electrolytic zinc plant, a phosphoric acid and phosphate fertilizer plant, two sulfuric acid plants, a 160-acre tailings impoundment, and several hundred acres of heavy metals contaminated soils (JEG 1988, TerraGraphics 2000a). Major products of the Bunker Hill operation were lead, zinc and zinc alloys, zinc oxide, cadmium, silver, hard (antimonial-arsenical) lead, gold ore, copper matte, cobalt, sulfuric acid, nickel, phosphoric acid, and four grades of fertilizer (BCI 1992). During the 1960s and 70s, Bunker Hill supplied approximately 25% of the primary lead refined in the United States with a daily production capacity of over 300 tons of metallic lead. Extensive remedial actions and lead health assessments have been accomplished at the BHSS. The recent Five Year Review of the BHSS Project provides a detailed summary of those activities (TerraGraphics 2000a).

The Lower Basin area includes 11 lateral chain lakes and extensive wetlands, located adjacent to the main channel and within the CDA River's floodplain. These marshes and lakes provide an extensive recreational area between the town of Cataldo and Lake Coeur d'Alene. Camping, fishing, boating, swimming, hunting, and wildlife photography/observation are popular activities throughout the lower CDAB. There are no incorporated cities between Cataldo and Harrison at the mouth of main River. However, there are a few small unincorporated village areas and several rural residences.

Cataldo Mission Flats, located near the historic Cataldo Mission, was originally a Tribal farm consisting of native hay meadows and pasture. Mine tailings, and effluent from other sources, were deposited in the river bed adjacent to the flats as the mining industry developed in the upstream basin. Sediments eventually inhibited river boat navigation to the Mission, and were subsequently dredged and deposited on the flats. Such dredging ceased in 1930, when river boat navigation was discontinued. During the early twentieth century, reworking of the metal-rich sediments near Cataldo resulted in significant disturbance of the CDA River Basin floodplain (USGS 1990).

By the 1950s, mine tailings piped from the river covered 2,000 acres of the Cataldo Mission Flats to an average depth of twenty-five to thirty feet. Sediment dredging, pumping 7000 gallons of water per minute, and excavating some 500 tons of contaminated river sediments per day, continued until 1968. Approximately 72 million tons of this sediment contaminated with mine tailings have been discharged into the CDA River (Krieger 1990, Weston 1989).

Approximately forty acres of the sediments deposited on the Cataldo Flats have not developed a stable vegetation cover. These barren areas, typified by milled ore deposits, are subject to drying during the summer months. Off-road vehicle enthusiasts use the barren areas for recreation, further retarding vegetation and increasing their own risk of heavy metals exposure. Under these conditions, winds entrain the highly mobile fine materials to such a degree as to occasionally reduce driving visibility.

The materials deposited on the flats are a heterogeneous mix ranging from milled ore, high in zinc, lead, and cadmium, to typical river sand and gravel. Alluvial sediments throughout the CDAB have extremely high concentrations of arsenic, lead, cadmium, zinc, and other trace elements (Krieger 1990). The sediments act as both a sink and a source of contamination, and their transport affects the concentrations of heavy metals in the soil, biota, surface water, and groundwater. High water flows, especially during winter and spring, scour sediments from the banks and bottom of the river and transport elevated quantities of metals downstream. When the flows decrease, the metals accumulate in the slow-moving sections of the river, in the lateral lakes, and downstream in Lake Coeur d'Alene. Sediments deposited on the floodplain become contaminated soils. Heavy metals contamination extends throughout the river system, including approximately 30 miles of the lower CDAB, the lateral chain lakes, and the northern two-thirds of Lake Coeur d'Alene (Haness 1991).

1.1.2 Public Health Concerns

The Bunker Hill Company mining and smelting complex closed in 1981. The site was added to the National Priorities List (NPL) in 1983, and the subsequent Lead Health Study was conducted jointly by state, federal, and local health agencies the same year (PHD 1986). This comprehensive survey of lead poisoning and exposures in the community showed elevated levels of lead in blood among area children, including those born after the smelter closure. Since the early 1970s, the exposure pathways and human health impacts associated with exposure to heavy metals have been studied extensively at the BHSS. Over the past 15 years, over 4,000 children living within the site have been tested for blood lead levels. Up to 75 percent of the preschool children tested (throughout the 1970s and early 1980s) had elevated blood lead levels ($10 Fg/dl) (JEG 1988). Blood lead levels of BHSS children in the early 1980s averaged around 15 Fg/dl, while today, the average blood lead level of children is near 4 Fg/dl. About 6% of children have blood lead levels $\geq$10 Fg/dl (TerraGraphics 2000a).

Residual contamination in community soils and dusts was identified as the primary source of lead exposure to children. The primary route of exposure has been identified as incidental ingestion of soils and dusts by ordinary hand-to-mouth and play activities (TerraGraphics 2000a). These same exposure

pathways potentially exist for individuals throughout the CDAB. Soil lead values near the river downstream of the Bunker Hill site typically range from 2,000 to 12,000 mg/kg while those in the upper Basin range from 500 to 25,000 mg/kg. Generally, soil samples average 2500-2800 mg/kg lead throughout the CDA River Valley (Neufeld 1987, Haness 1991, Lustig 1991).

In 1991, the Center for Disease Control's (CDC's) intervention level of 25 Fg/dl of lead in blood for children was revised downward to 10 Fg/dl. In response to reductions in the health intervention level in children, the geographic area of human health concern surrounding the Bunker Hill Site has continued to expand. However, minimal testing of residents upstream and downstream from the site for lead and other heavy metals had been done. Children tested in the early 1970's, living outside the boundaries of the BHSS, often exhibited blood lead levels of 40 to 50 Fg/dl. No organized screening occurred beyond the site boundaries from 1975 until 1996.

In addition to CDC's concern about blood lead levels in children, the Agency for Toxic Substances and Disease Registry (ATSDR) expressed concerns as part of a Health Consultation done on the Coeur d'Alene River in June, 1991. That health consultation indicated that contamination within the Basin was not well characterized and that it may represent a threat to public health. It was recommended that periodic monitoring of soil and sediments occur where human contact is likely, that persons who have frequent contact with contaminated soils and sediments be identified, and that the use of untreated drinking water from the river or a shallow aquifer be discouraged.

In 1996, the State of Idaho, the Panhandle Health District (PHD) and ATSDR began consideration of the entire CDA River Basin for health-related concerns similar to those of the BHSS. The reason for this concern was based upon known historical mining practices in the BHSS site, the CDCs blood lead action level, and the Health Consultation accomplished by ATSDR. Additionally, fate and transport studies at the BHSS site indicated that metals contamination had spread from the site along the Coeur d'Alene River, into the chain lakes area, into Lake Coeur d'Alene, and possibly into the Spokane River (SAIC 1990). A large-scale, multimedia sampling study within the Basin was performed in 1996 by the State of Idaho, USEPA, and ATSDR (IDHW 1999).

To better define the nature and extent of the contamination in the Basin, EPA Region X began additional RI/FS data collection activities that are currently ongoing through the federal contractors URS Greiner and CH2M Hill. The expansion of the region of concern from the BHSS to the greater Coeur d'Alene Basin requires that a Human Health Risk Assessment (HHRA) be performed for the Basin. It is important that the HHRA be conducted comprehensively, within the context of the history of lead health problems in the region, and be consistent with ongoing health intervention actions at the BHSS. The State of Idaho, in conjunction with Region X, has performed the HHRA for the Basin, while Region X will coordinate other RI/FS activities for the Basin. It is the desire of the State to coordinate all HHRA activities with ongoing RI/FS activities, in a manner consistent with USEPA Risk Assessment Guidance.

The ATSDR and the Washington Department of Health have independently conducted both Health Consultations and issued Health Advisories for the Basin area in the last two years. The Idaho Department of Health and Welfare, Division of Health (IDOH) requested technical assistance from ATSDR in 1998 to evaluate the likelihood that the levels of lead, mercury, and cadmium detected in fish caught in the Coeur d'Alene lateral lakes would result in adverse health effects if these fish were eaten (ATSDR 1998). Additionally, the USEPA requested ATSDR to conduct an independent review of the environmental sampling data from 47 Common Use Areas (CUAs) and 80 residential properties in the Coeur d'Alene Basin in the Spring of 2000. The purpose of the health consultations was to assess the potential for public health hazards based on environmental data. A public health hazard is defined by ATSDR as sites that pose a public health hazard due to the existence of long-term exposures (> 1 year) to hazardous substances or conditions that could result in adverse health effects (ATSDR 2000a).

In evaluating the fillet fish data for northern pike, bullhead catfish, and yellow perch, ATSDR concluded that adverse health effects are not likely to occur from ingestion of fish from the lateral chain lakes and other sources of lead are present in the Coeur d'Alene Basin that may affect residents if chronic exposures occur (ATSDR 1998).

Specifically, ATSDR was asked to assess whether Early Action Levels (EALs) proposed by the USEPA to remediate certain homes and CUAs were protective of public health. Based on the information available for the 47 CUAs east of Harrison, ATSDR found that the EALs proposed for antimony, arsenic, cadmium, and lead may not provide an adequate margin of safety for area residents. ATSDR also concluded that recreational visitors to the CUAs are not likely to experience adverse health effects from metals below the EALs. The recommendation that ATSDR provided in the health consultation was to notify area residents of the hazards posed by recreational activities at the CUAs along the Coeur d'Alene River (ATSDR 2000b).

The health hazards from lead contamination in soil, indoor dust, and tap water to children using the residential homes data were evaluated differently than the CUAs. The potential health threat was evaluated three ways, by 1) calculating an estimated daily intake (dose) and comparison to an Intake of Concern for the population (IOC), 2) estimating expected blood lead levels through use of the EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead, and 3) estimating blood lead levels through an ATSDR integrated exposure regression analysis model for use at lead sites. Based on the three methodologies utilized in the health consultation and data from the residential homes, a public heath hazard may exist for children living at more than half of the residences sampled by the USEPA in 1998 and 1999. Children in approximately 50 homes had estimated lead exposures twice the IOC and/or estimated blood lead levels in excess of the CDC action level of 10 µg/dl. Results of the evaluation suggest that children one to two years old may be the population of concern for elevated blood lead levels. Increased hazard may also be likely if other routes of exposure unaccounted for in the calculations, such as lead based paint, consumption of biota, and recreational activities in the Basin, are a significant route of exposure to lead. ATSDR made recommendations including differing

intervention strategies based on the level of risk that included continuation or initiation of blood lead monitoring and the current intervention program (ATSDR 2000a).

In addition to the published ATSDR health consultations for the Coeur d'Alene Basin, the Spokane Regional Health District, Washington State Department of Health, and the Washington State Department of Ecology recently issued a health advisory for consumption of Spokane River fish (June 2000). The advisory concluded that:

- all of the fish sampled in the Spokane River had elevated lead concentrations (rainbow trout, mountain whitefish, and large-scale sucker),
- lead levels in whole fish were significantly higher than levels found in fillets,
- no increased risk exists for most people who eat fillets from fish caught in the Spokane River,
- children should not eat whole fish or any meals prepared using whole fish, and
- adults (in particular, pregnant women) should limit the number of whole fish eaten.

1.2 STUDY POPULATIONS AND STUDY AREA

The study area is defined as the CDA Basin, which includes the South Fork of the Coeur d'Alene River and tributaries, and the main stem of the CDA River for approximately 53 miles from the Idaho/Montana border to Lake Coeur d'Alene, excluding the 21 square-mile Bunker Hill Superfund Site. The population includes those individuals living throughout the defined study area, but is limited to those individuals living within the CDAB at the time health and environmental surveys were performed (i.e., 1996-1999). For the blood lead surveys, children are defined as individuals older than 6 months, but less than or equal to 9 years of age. Sub-categories of this age group, (up to 84 months of age) including infants, preschoolers and toddlers are used throughout the HHRA to assess risks to children using the EPA Lead Model (USEPA 1994d; USEPA 1998f). Adult females are defined as women of reproductive age between the ages of 17 years and 49 years. The remainder of the population is comprised of all individuals that do not fit these categories.

It is estimated that approximately 10,000 people reside in about 5000 homes located in the defined area. A comprehensive review of the population and demographics of the CDAB is discussed in Section 3.0.

1.3 PURPOSE AND OBJECTIVES

The main purpose of this HHRA is to determine the extent of heavy metal contamination in environmental media that may expose current or future residents or visitors to the CDAB, to evaluate the potential human health risks associated with exposure to those contaminated media, and to provide information for risk managers to evaluate need for remedial action and development of associated clean-up criteria.

The specific objectives of this document are:

1. To review and summarize health and environmental data available for the CDAB,
2. To select the chemicals of potential concern (COPC),
3. To identify potentially exposed residents and visitors, exposure pathways and populations of concern,
4. To summarize toxicity information for the COPCs,
5. To characterize human health risk related to lead and other metal exposures,
6. To evaluate potential risk-based clean-up action levels, and
7. To identify uncertainties associated with the entire HHRA process.

1.4 SCOPE AND LIMITATIONS

The baseline risk assessment is an evaluation of the potential threats to public health from site contaminants in the absence of any remedial action (the no action alternative), as defined and required by Section 300.430(e)(6) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The results of the baseline risk assessment are used to determine the need for remedial action and to establish risk-based remediation goals.

The primary tasks in performing a risk assessment include data collection, data evaluation, exposure assessment, toxicity assessment and risk characterization. In addition, scoping and development of conceptual site models (CSMs) were performed so that the ultimate goal of risk assessment, assessing the current situation, also provides baseline information for instituting risk management measures to protect human health.

For the purposes of this HHRA, the CDAB is defined to be the area from the Idaho-Montana border to Harrison. The 21 square-mile BHSS is excluded from this assessment. Other areas, such as regions south of Harrison, Blackwell Island, Corbin Park beaches, and other areas identified by the State, EPA and the Coeur d'Alene Tribe, are also included as part of this HHRA.

1.5 REPORT STRUCTURE

This report is structured to follow the general Human Health Risk Assessment process.

Section 1.0 Introduction provides a brief description of community and industrial development in the Basin area, a short history of health concerns related to mining pollution, the study area, and the purpose, objectives, and limitations of the report.

Section 2.0 Data Evaluation discusses the organization of the RI/FS process and the data that is used throughout the HHRA. The data are organized by geographic area and media. Data quality evaluations are provided to assess the reliability of the information used in the assessment. Chemicals of potential

health concern (COPCs) are identified through a screening process comparing available media-specific concentrations to health related criteria. Eight metals were selected for further evaluation in this process. Those metals are antimony (Sb), arsenic (As), cadmium (Cd), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), and zinc (Zn).

Section 3.0 Exposure Assessment identifies those population groups that are of special concern for potential human health effects associated with the COPCs . Generally, longtime local residents are of concern with respect to carcinogenic and chronic non-carcinogenic health effects due to most of the metals. Women of reproductive age, as they represent the fetus, and children, are of most concern for lead. Exposure pathways, or the routes and mechanisms through which people contact and take these metals into the body are identified. Formulae are developed to quantify these intakes by identifying and selecting appropriate values for exposure factors, such as how much time children spend in particular play areas and how much soil they consume during those activities. Exposure point concentrations (EPCs) are developed that estimate the concentration of each contaminant in each media that people contact. These results are then combined to estimate characteristic intakes or how much of each contaminant is taken into the body by members of the sensitive population groups. Intake calculations are developed for the non-lead chemicals, or those with chronic or long-term health concerns in this section. Sub-chronic intake rates for lead are developed in Section 6.0.

Section 4.0 Human Health Toxicity Assessment discusses the health concerns associated with each of the COPCs and the routes of exposure and toxicological mechanisms that can lead to adverse health effects. Critical toxicity criteria such as no observable effect or "safe" levels are identified and discussed.

Section 5.0 Risk Characterization for Non-Lead Chemicals assesses the health risks associated with the characteristic intakes developed in Section 3.0 by comparison to the toxicity criteria identified in Section 4.0. This is accomplished for both carcinogenic (cancer causing) and non-carcinogenic health effects and for the combined effects of metals with common health effects endpoints. Risks are evaluated for both the resident population, those that currently live in the area, and for the Native American population that traditionally, or may in the future, practice subsistence lifestyle in the Lower Basin.

Section 6.0 Characterization of Lead Health Risks is accomplished separately from the other contaminants of concern for a number of reasons. These factors are discussed and observed blood lead levels from health department surveys conducted throughout the Basin are summarized with the results of special follow-up investigations of lead poisoned children. Site-specific quantitative analysis of exposure survey data relating observed blood lead levels to measured environmental variables at individual residences is accomplished. Lead exposure pathways are identified and quantified through route-specific exposure factors and intake routes are quantified. Predictive blood lead modeling, using both USEPA recommended and site-specific exposure factors, is accomplished and compared to observed results. These models are then used to project blood lead levels for current and future use

scenarios. Native American subsistence intake rates are also developed and compared to similar rates in other populations.

Section 7.0 Uncertainties in Risk Assessment discusses the significance of the results of the risk characterization and those factors that may lead to possible overestimation or underestimation of risk. Uncertainties are discussed relative to development and use of the HHRA database, the non-lead estimates of risk developed in Section 5 and the observed lead health problems and risk calculations developed for lead in Section 6. Concerns that interest groups may have and those factors that risk managers may want to consider in the development of risk reduction strategies are included in this section.

Section 8.0 Summary and Conclusions is developed as a stand alone chapter that is available for public review. This section summarizes the entire document, repeats important findings from previous sections, and discusses the results of conclusions of the risk assessment.
Section 8 is also being distributed publically as an abbreviated form of the risk assessment for those less interested in the details of the document. An **Executive Summary** is also available that briefly summarizes the major findings of the risk assessment.

Appendices The Appendices for this document are voluminous and are produced only in electronic format on CD. The CD is attached to the back cover of the report.